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ADMINISTRATION REPORTS

OF THE

AGRICULTURAL CHEMIST, ENTOMOLOGIST, AND MYCOLOGIST

OF THE

DEPARTMENT OF AGRICULTURE, MADRAS, FOR 1935–36

(DETAILED REPORT)

MADRAS
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DETAILED SCIENTIFIC REPORT OF THE GOVERNMENT AGRICULTURAL CHEMIST FOR THE YEAR 1935–36.

I was in charge of the section throughout the year under report.

2. The different branches of the section were under the control of gazetted officers as follows :—

(i) Analytical and Advisory	..	M.R.Ry. T. S. Ramasubrahmanya Ayyar Avargal.
(ii) Physical Chemistry	..	M.R.Ry. T. Lakshmana Rao Avargal (till 16th December 1935).
(iii) Soil Physics	... ...	Dr. A. Subba Rao (till 1st March 1936).
(iv) Microbiology	... ...	M.R.Ry. P. D. Karunakar Avargal.
(v) Sugarcane work	...	M.R.Ry. G. Ganapathi Ayyar Avargal.
(vi) Soil Surveys	... ...	M.R.Ry. C. V. Ramaswami Ayyar Avargal (till 1st March 1936).
(vii) Malting of Cholam	...	M.R.Ry. M. Suryanarayana Garu (from 5th June 1935).

The Nutrition branch was under my immediate and personal supervision.

3. The work done in the section during the year is reported on, under the sub-heads, " I. General—including analytical and advisory work and II. Research in soil science, plant and animal nutrition, microbiology and agricultural industries."

I. GENERAL.

4. *Meteorology.*—Meteorological records were maintained, throughout the year, with a daily recording of climatological conditions at 8·00 hours, and the compilation of a monthly weather review, published monthly in the Madras Agricultural Journal, from rainfall data received from the Agricultural Research Stations in the Presidency and from the Indian Daily Weather Report published at Poona. Table below gives a summary of observations recorded at Coimbatore for the year 1935–36.

Table I.

Annual weather report, 1935–36.

Month and year.	Temperature.					
	Absolute maximum.	Absolute minimum.	Mean maximum.	Departure from normal.	Mean minimum.	Departure from normal.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	°F.	°F.	°F.		°F.	
1935—						
April	99·0	68·2	95·5	— 0·4	72·7	— 0·2
May	99·8	71·2	97·6	+ 3·3	74·9	+ 1·0
June	98·8	70·4	93·4	+ 4·2	73·7	+ 0·6
July	94·0	67·2	88·0	+ 0·9	72·9	+ 0·9
August	92·2	67·5	89·1	+ 1·2	71·2	— 0·5
September	95·2	62·2	89·3	+ 0·3	70·0	— 0·6
October	93·5	65·2	87·8	Nil.	70·9	+ 0·7
November	91·0	59·8	86·1	+ 1·4	68·1	— 0·6
December	88·8	58·3	84·9	Nil.	65·8	Nil.
1936—						
January	91·8	58·8	87·8	+ 1·8	64·4	Nil.
February	93·5	57·5	91·0	+ 0·4	67·9	+ 2·4
March	97·0	62·8	94·1	— 0·4	70·5	+ 1·1

Month and year.	Rainfall.			Humidity.		Wind.
	Rainfall for the month in inches.	Departure from normal.	Number of rainy days.	Humidity at 8 hours.	Departure from normal.	Mean daily wind velocity M.P.H.
	(8)	(9)	(10)	(11)	(12)	(13)
				PER CENT.		
1935—						
April	3·07	+ 0·91	7	72·2	+ 1·4	2·3
May	0·72	— 2·49	1	65·2	— 6·2	3·1
June	0·32	— 1·02	1	63·8	— 5·5	5·8
July	0·57	— 0·70	2	65·5	— 5·9	8·1
August	1·38	+ 0·39	4	75·0	+ 1·7	4·2
September ..	0·70	— 1·74	2	69·1	— 5·9	5·6
October	5·42	— 0·33	9	78·9	Nil.	2·0
November	3·27	— 1·26	3	74·2	— 7·1	1·8
December	0·84	— 1·49	4	75·1	— 4·6	2·6
1936—						
January	Nil.	— 0·48	Nil.	73·8	— 1·7	2·5
February	1·21	+ 0·81	1	75·4	+ 3·9	2·2
March	1·72	+ 0·92	2	73·4	+ 3·7	1·5

	INCHES.		INCHES.
Total rainfall for 1935–36 ..	19·22	Departure from normal ..	— 6·48
Total number of rainy days ..	36		

The year was another disappointing one from the agricultural point of view. The total rainfall was about 25 per cent below normal. Rainfall was in defect in most months and most markedly so in May, June and July and again during the transition period (September) of the calendar year 1935. The south-west monsoon appeared late and failed to give any appreciable rainfall, the north-east monsoon was, however, fairly strong.

In consequence of the scanty rainfall during May, June and July, day temperatures ruled high and were markedly above the average.

5. *Analytical and Advisory.*—The statement below gives details of samples analysed and reported on during the year. The statement does not include samples analysed in connexion with original investigations dealt with under "Research." A total of 2,095 samples of soil has to be added to the totals given, due to samples analysed in connexion with the Tungabhadra Project Soil Survey.

TABLE II.

Particulars.	Research.	Agricultural department.	Other Government departments.	Ryots and private persons.	United Planters' Association of South India.	Total.
1 Soils	53	72	1	2	14	142
2 Manures, composts.	16	44	4	7	12	83
3 Waters	15	33	48	1	..	97
4 Feeding stuffs ..	..	71	72	..	..	143
5 Cane juices ..	..	627	13	..	..	640
6 Field experiments, grains and straws.	160	..	..	..	..	160
7 Miscellaneous ..	14	6	2	2	..	24
Total for 1935–36 ..	258	853	140	12	26	1,289
Total for 1934–35 ..	570	571	147	15	16	1,319
Total for 1933–34 ..	414	359	75	19	14	881

Out of the total of 19 manures and manure mixtures received from firms and from the United Planters' Association of South India, 14 were accompanied by guarantees, and of the 14 samples analysed only one sample was found to be below the guarantee.

A sum of Rs. 619 was received as analytical fees, against Rs. 262–8–0 in 1934–35 and Rs. 477 in 1933–34.

In addition to analysis and reports of a routine nature, the section dealt with numerous requests for advice, on matters connected with the Chemistry of soils, manures and feeding stuffs, from other officers of the Research Institute and in the districts, on problems connected with their work. Other Government departments, i.e., the Industries, Jail, Public Health and Medical departments, had samples analysed for them and advice rendered.

A number of samples of interest were analysed and details are given below for some of them :—

(*a*) A sample of rice mill ash, sent by the Superintendent, Merthi-Subbangudi Estate, Balehonnur P.O., for advice as to its suitability as a manure, was analysed and found to contain 0·25 per cent nitrogen, 0·60 per cent potash, 0·48 per cent phosphoric acid and 88·5 per cent insoluble mineral matter. The material had practically no manurial value.

(*b*) A sample of ashy bloom found to occur on the stalks and leaves of the cholam plant was sent by the Millets Specialist for identification and analysis. The material had no taste or odour and was of a powdery consistency and consisted of a wax melting at 83–84°C. No information is available as to its physiological significance.

(*c*) The Superintendent, Agricultural Research Station, Pattambi, sent in a sample of jack leaves for estimation of its feeding value. It is reported that jack leaves find great favour among owners of milch goats as a galactogogue. It is a general belief that plants with a milky sap, when fed to goats, stimulate milk flow. Chemical analysis of the jack leaves did not show any special merit over the herbage of grasses, except for a high calcium and potash content. Calcium is of undoubted utility to the goat but it is not known which is the factor involved in increasing milk yield. The latex of the jack fruit tree will be investigated. The analysis of the jack leaf was as follows :—

Constituents.	Air-dry basis.	Original moisture basis.
	PER CENT.	PER CENT.
Moisture	9·78	65·86
Ash	10·31	3·90
Protein	2·48	0·94
Ether extractives	3·93	1·49
Crude fibre	22·94	8·47
Albuminoids	1·99	0·75
The ash had the following composition :—		
Lime (CaO)	1·14	0·47
Magnesia (MgO)	0·68	0·26
Potash (K_2O)	2·07	0·78
Phosphoric acid (P_2O_5)	0·40	0·15
Iodine (I)	Traces.	Traces.
Manganese (Mn_3O_4)	0·20	0·08

(*d*) A sample of cashewnut fruit refuse, after extraction of juice for distillation of arrack, was sent by the Agricultural Demonstrator, Ponnani, to see if it had any manurial value. The sample (laboratory No. 597/35-36) was very moist containing over 60 per cent moisture, and analysed as below :—

Heads of analysis.	Air-dry basis.	Original moisture basis.
	PER CENT.	PER CENT.
Moisture	5·1	59·5
Loss on ignition	91·5	39·0
Insoluble mineral matter	1·77	0·76
Soluble mineral matter	1·63	0·74
	100·00	100·00

Heads of analysis	Air-dry basis. PER CENT.	Original moisture basis. PER CENT.
Nitrogen (N)	1·85	0·79
Phosphoric acid (P_2O_5)	0·27	0·12
Potash (K_2O)	0·31	0·13
Lime (CaO)	0·30	0·13

This waste material would find use as a nitrogenous material.

(*e*) A sample of coffee manure (laboratory No. 499/35-36) was analysed for the Stanmore Estate (Anamallay). The composition of the manure was 50 per cent nicifos, 38 per cent muriate of potash, 7 per cent concentrated super and 7 per cent bonemeal. The material analysed as follows :—

	PER CENT.
Moisture	4·99
Loss on i nition	44·55
Insolubles	0·96
Nitrogen	8·60
Potash	17·31
Phosphoric acid	14·28

The nitrogen and potash contents in the manure were 0·6 per cent and 0·7 per cent less than the guarantee respectively, while the phosphoric acid content was about 1 per cent above.

(*f*) A sample of sugar beet (Laboratory No. 1137/35-36) variety vilmorin B, was analysed for its sugars. The sample was sent by the Superintendent, Livestock Research Station, Hosur Cattle Farm. When the material was submitted to hot water digestion method, the sucrose content was 8·81 per cent. When the juice was extracted by expression, about 52·5 per cent was extracted and this juice analysed as follows :—

	PER CENT.
Brix	15·09
Sucrose	9·79
Glucose	0·30

The sample of beet was of fair quality with a purity of about 65 per cent.

(*g*) The Deccan Company, Mangalore, sent two samples of milled fish—one salted and the other unsalted—for analysis. Both the samples were of average quality but the unsalted contained 1 per cent more nitrogen.

Heads of analysis.	Laboratory No. 680/35–36 —Salted fish. PER CENT.	Laboratory No. 681/35–36 —Unsalted fish. PER CENT.
Original moisture	11·2	8·66
Nitrogen	5·20	6·26

(*h*) A number of samples of composts have been analysed for the several Research stations who have prepared these by the Indore process and the ordinary way. In general, from the analysis, it is found that the composts by the Indore process compares favourably with the cattle manure and the manure obtained from the loose-box system has always been the best.

The Farm Manager, Nandyal, sent six samples of composts prepared by the Indore method using three different kinds of materials, viz., (i) Jonna stubbles, (ii) Cotton stalks crushed in mortar mill before starting the heap and (iii) mixed wastes containing farm sweepings. Well rotten cattle manure, with urine, earth and ashes was used as starter. In each kind two heaps were started, one of which received a double dose of the starter. In the following table are given the results of chemical analysis of these six composts. The double dose starter does not appear to have materially benefited the chemical composition of the resulting product.

TABLE III.

Composts from Nandyal.

Laboratory No. (1935–36).	601. Cotton stalks. Starter single dose.		602. Cotton stalks. Starter double dose.		603. Jonna stubbles. Starter single dose.	
Heads of analysis.	Dry basis.	O.M. basis.	Dry basis.	O.M. basis.	Dry basis.	O.M. basis.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Moisture ..	..	41·2	..	45·0	..	49·8
Loss on ignition ..	21·3	12·5	23·6	13·0	23·8	12·0
Nitrogen (N) ..	0·26	0·15	0·30	0·16	0·34	0·17
Potash. (K_2O) ..	0·80	0·47	0·83	0·45	1·26	0·64
Phosphoric acid (P_2O_5).	0·27	0·16	0·33	0·18	0·38	0·19
Humus	3·22	1·89	3·00	1·65	3·26	1·64
Sand, etc.	49·8	29·3	47·6	26·2	46·2	23·2

Heads of analysis.	604. Jonna stubbles. Starter double dose.		605. Mixed waste. Starter single dose.		606. Mixed waste. Starter double dose.	
	Dry basis.	O.M. basis.	Dry basis.	O.M. basis.	Dry basis.	O.M. basis.
	(8)	(9)	(10)	(11)	(12)	(13)
Moisture	..	45·1	..	32·6	..	36·9
Loss on ignition ..	22·3	12·3	17·3	11·7	20·1	12·8
Nitrogen (N) ..	0·32	0·18	0·23	0·15	0·27	0·17
Potash (K_2O) ..	1·08	0·59	0·85	0·58	1·06	0·67
Phosphoric acid (P_2O_5).	0·38	0·21	0·25	0·17	0·28	0·18
Humus	3·30	1·81	3·53	2·38	3·30	2·08
Sand, etc.	47·1	25·8	52·3	35·3	49·4	31·2

O.M. basis = Original moisture basis.

II. RESEARCH.

SOIL SCIENCE—SOIL SURVEYS.

6. *Tungabhadra Project Soil Survey.*—The soil survey of the Tungabhadra Project command was completed during the year under report and a detailed report has been submitted.

The findings may be summarized as follows :—

(i) The soil types met with were classified under several heads according to their colour and presence or absence of gypsum in their lower horizons. This classification was justified by the sharp differences found in their physical and chemical characteristics. The black soils were found to occupy about 80 per cent of the total area and the red and mixed soils the remainder.

(ii) The survey has led to the formulation of a hypothesis regarding the origin of the different types of soil, in which the origin of the soils has been correlated with the type of parent rock. The black soils appear to have been formed from rocks containing soda and soda-lime felspars, and have a high $CaO + MgO$ content, while the red soils have been formed from rocks containing potash felspars, the intermediate types being formed from intermediate types of rock. The red soils had a low $CaO + MgO$ content, which is entirely in keeping with this view.

(iii) The physical and chemical properties of the two broad classes of black soils and red soils were characteristically different, the former having a high clay content, high base exchange and absorption capacity and a high SiO_2/R_2O_3 ratio in the clay complex, and high lime status. The latter had a low clay content, low SiO_2/R_2O_3 ratio and low base exchange and absorption capacity and low lime status.

The behaviour of these two classes towards irrigation would be entirely different. The black soils are those from which trouble might be anticipated on the application of irrigation and were subjected to a very detailed study of their water relations.

(iv) The detailed study of the black soils indicated that, considering their low permeability and high moisture holding capacity by virtue of their high clay content, they would have a poor capacity for internal drainage, but with a high capacity for surface drainage. These factors would not favour water draining down to the subsoil layers and by its accumulation there giving rise to undesirable concentration of salts, but would favour rapid run off of water from its surface, and assist in leaching out salts from there. It was therefore concluded that the black soils are capable of being irrigated without fear of the development of alkalinity.

(v) The waters of the Tungabhadra were analysed at periodic intervals, and were found to be of high quality with a low pH, and low salt content and were thus eminently suited for irrigation.

(vi) The irrigated areas near Siruguppa and under the tanks and the river Hagari were investigated and, it was seen that those under Tungabhadra irrigation showed no signs

of alkalization or deterioration, despite the fact that these lands have been under irrigation for centuries. The lands under tanks and the Hagari were found to be saline and to have undergone deterioration, often to a considerable degree. This effect was due to the poor quality of the irrigation water from the tanks and the Hagari river. These results emphasise the utmost importance of suitable irrigation water.

(vii) The data collected, all point to the conclusion that the black soil area was suitable for irrigation, if applied with caution, and with the provision of safeguards of drainage to obviate danger of water-logging.

(viii) The recommendations made were—

(*a*) to provide for proper drainage system as a corollary to the water distributary system,

(*b*) to have a system of irrigation based on the class of soil, and type of crop, to obviate indiscriminate use of water, and

(*c*) to initiate fundamental research on physico-chemical problems connected with the reaction of black soils to irrigation so that, when problems arise on the inauguration of the project, information will be available for solving them.

7. *Toludur Project.*—A soil survey of the area under the command of the Willingdon Reservoir in the Vriddachalam taluk, consisting of 26,000 acres was carried out to investigate the reasons for the development of alkalinity. The soil survey and the analytical work in that connexion was completed and a detailed report submitted during the year under report.

The findings may be summarised as follows :—

(i) The water from the reservoir did not contain large quantities of salts, though the pH was 8·0. The average analysis of water taken at different parts of the system was as follows :—

Total solids ...	...	26·0	parts per 100,000
Suspended solids ...	...	6·6	„ „
pH	...	8·0	

(ii) The soils examined were clays with a high maximum water-holding capacity, pore space and hygroscopic coefficients and consequently with poor internal drainage capacity. The table below gives average values for some of the constants obtained :—

TABLE IV.

Depth of soils examined.	Clay.	Silt.	Fine sand.	Coarse sand.	Maximum water holding capacity.	Pore space.	Hygroscopic coefficient.	pH.	Soluble salts 1 : 5 of water.
	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.		PER CENT.
0″—6″	39·2	13·7	27·0	19·0	60·3	56·2	6·01	8·1	0·166
6″—12″	41·4	14·0	24·0	21·1	63·8	58·9	6·06	8·2	0·103
12″—24″	39·9	15·8	25·9	18·7	64·0	57·3	6·39	8·1	0·044
24″—36″	38·6	15·1	26·0	20·2	68·4	58·3	6·04	8·4	0·208

(iii) It would appear that one of the chief contributory causes for the occurrence of alkalinity was lack of proper drainage since the alkaline areas were observed to be in patches lying in hollows, and into which seepage water from surrounding areas had drained. The two villages of Kothattai and Tolar were the worst affected in this respect.

(iv) It was recommended that drainage facilities be provided to prevent accumulation of water, and the application of green leaf at the rate of 5,000 lb. per acre, and in addition application of lime, sulphur or gypsum to ameliorate the alkalinity.

8. *Field experiments*—(i) *Molasses experiment on paddy.*—The experiment was continued during the year and the yield was as follows :—

Average yields of four treatments in the molasses experiment, B. Block, Paddy Co. 1—1935-36.

	Yield per acre.	
	Grain.	Straw.
	LB.	LB.
1. Control	2,990	3,455
2. 5 tons molasses ..	2,770	3,300
3. 7½ tons molasses ..	2,829	3,149
4. 4 tons molasses plus ammonium sulphate.	3,085	3,481

The molasses plots even at 7½ tons per acre did not give better yields than control, and even in combination with ammonium sulphate gave a yield not significantly above that of the control plot.

(ii) *Residual effect of Molasses on Chitrai cholam.*—The residual effect of molasses on chitrai cholam was tested in field No. 59-A. It was seen that the plots to which molasses had been applied gave a yield of 1,888 lb. grain per acre, against 1,529 lb. in the control plot. The corresponding yields of straw were 6,444 lb. and 5,809 lb. per acre. A slight residual effect was seen.

These experiments will be now discontinued and it may be stated that laboratory and field studies of the effect of molasses application when read together indicate that the material has little or no effect on the physical or chemical properties of the soil, and that as a manure its application is one not attended by significant increases of yield, to make it an economic proposition. The question of handling the material, and incorporating it in the soil are practical drawbacks in the way of its use.

(iii) *Green manure experiments.*—The green manure experiment in A block of Central Farm wet lands was continued and the results are given below :—

Average yields per acre—Paddy G.E.B. 24.

	Yields per acre.	
	Grain. LB.	Straw. LB.
Control	2,749	2,677
Green manure 2,000 lb. per acre	2,728	2,842
Do. 4,000 lb. per acre	2,756	2,810
Do. 6,000 lb. per acre	3,062	2,978
Do. 8,000 lb. per acre	3,075	2,945
Do. 10,000 lb. per acre	2,933	3,148
Do. 12,000 lb. per acre	3,051	3,073

It will be seen that yields increased with the increasing dosage of green manure, but that the optimum yield was at 6,000–8,000 lb. green manure.

(iv) *Use of activated sludge process effluent for paddy.*—This experiment was repeated this year but had to be abandoned for various reasons, an unfavourable season being one. Seedlings were analysed periodically during period of stand of the paddy, for their nitrogen content. The results were as follows :—

Date of planting—16th August 1935. Date of harvest—13th December 1935.

Rounds of analysis.	Date of sampling.	'Effluent' plots,		'Channel water' plots.	
		Original moisture.	Total N.	Original moisture.	Total N.
		PER CENT.	PER CENT.	PER CENT.	PER CENT.
1	28th Sep. 1935.	82·04	2·69	81·91	2·12
2	14th Oct 1935.	83·49	2·60	82·12	1·85
3	28th Oct. 1935.	81·34	1·96	79·05	1·22
4	11th Nov. 1935.	74·94	1·57	69·72	0·96
5	25th Nov. 1935.	66·64	1·58	58·78	0·89
6	9th Dec. 1935.	57·16	1·23	49·34	0·80
* 7	7th Jan. 1936.	11·32	1·13	27·29	0·76

* Dried hay.

The higher nitrogen content of the seedlings from the effluent plot, is notable. It would appear that the paddy plant is able to build up more nitrogen when supplied with effluent water. If the same effect is obtainable with grasses, it will be possible to enhance their nutritive value to a considerable extent, by using effluent water for irrigation. An experiment with sullage for grasses is under contemplation.

9. *Animal nutrition*—(i) *Maintenance requirements of working bullocks.*—This work was continued this year—

(*a*) *Requirements for heavy work.*—The protein requirement for heavy work was determined, using paddy straw and cotton seed as the ration. The work given was eight

hours mhoting. It was found that for this heavy work, the quantity of digestible protein required was in the neighbourhood of 350 grams, confirming the previous results with other combination of fodder and concentrates. These experiments extending over three years show that muscular work in the adult bullock, makes a definite call for additional protein in the ration, beyond all doubt. The ration though it may contain a sufficiency of calorigenic material, will not be able to supply all the requirements of bullocks during work, since apparently tissue protein is being broken down during the course of work and this has to be replaced by feeding additional protein.

The quantum of protein required for this purpose would appear to depend on the quantum of work performed; but work done till now does not indicate that the quantum of protein is a linear function of the quantum of work performed. It is proposed to investigate this aspect in future experiments, and to establish the mathematical relationship existing between the two quanta.

(*b*) *Requirements for maintenance.*—Till now, experiments have been carried out with chitrai cholam, periamanjal cholam and paddy straw and groundnut cake and cotton seed; another series of experiments was carried out with irungu cholam straw and cotton seed during the year. Irungu cholam straw is popularly held to have a much better nutritive value than either chitrai or periamanjal straw. A quantity of this straw was grown and supplied by courtesy of the Principal, on the black soils of the Central Farm, and was used for this series of experiments.

Results of three balance experiments showed that with this straw and cotton seed, the requirement for protein was in the neighbourhood of 100 grams per 1,000 lb. liveweight confirming previous work.

(*c*) *Digestible co-efficients of mixed ration.*—In the course of work on the maintenance requirements of bullocks the digestible coefficients of the ration were determined.

Table below gives details of the comparative digestible co-efficients of irungu and periamanjal straw and paddy straw.

	Dry matter.	Protein.	Fat.	Fibre.	Carbohydrates.
	PER CENT.	PER CENT.	PER CENT.	PER CENT.	PER CENT.
Irungu cholam straw and cotton seed.	54	30	72	64	57
Periyamanjal cholam straw and groundnut cake.	54	30	54	66	52
Paddy straw and cotton seed.	48	32	82	70	47

The similarity in the digestible coefficients of the three different straws is apparent. Irungu cholam cannot thus be said to have any marked superiority over periamanjal straw in its nutritive value.

(ii) *Mineral metabolism and allied problems.*—Work was started on this group of problems financed by a grant from the Imperial Council of Agricultural Research. Results of work are reported on in a separate report to the Imperial Council of Agricultural Research.

10. *Microbiology*—(i) *Physiological studies on sulphur organism.*—The effect of various organic and inorganic compounds on the sulphur oxidizing organism was tested with sulphur oxidation as the criterion. In general, it was found that the organism is able to utilize several organic compounds, proving that it is not an antotrophic bacteria, and that is different from *Thiobacillus thioxidans*. This organism would appear to be a new species.

Table showing relative efficiency of some selected media.

Nature of the medium.	Initial pH of the medium.	pH at the end of four weeks.	So_3—mgms per 100 cc of culture, less control uninoculated, at the end of four weeks.
1 Waksman No. I with $(NH_4)_2$ SO_4 ..	5·0	2·6	38·10
2 Waksman No. I with urea	5·0	3·1	48·88
3 Check-Waksman No. I with $(NH_4)_2$ SO_4 for the urea series	5·0	2·7	46·2
4 Waksman No. I with NaH CO_3 ..	6·6	5·7	39·80
5 Check-Waksman No. I with $(NH_4)_2$ SO_4 for the $NaHCO_3$ series	6·5	2·2	38·7
6 Waksman No. I ærated	5·0	2·3	78·60
7 Check-Waksman No. I with $(NH_4)2$ SO_4 unærated for the ærated cultures	5·0	2·3	47·6

(ii) *Studies in bio-antagonism.*—This work was continued, and it was found that the inoculation of the saprophyte, i.e., aspergillus 24 hours before infestation by the parasite Fusarium, definitely deters the growth and activity of the parasite. The result makes it possible to inoculate paddy during the process of soaking prior to sowing, which would confer immunity against the attack by the parasite, or at least minimize its ravages by the deterrant action of the saprophyte.

(iii) *Studies on Azotobacter.*—Preliminary studies were started on the effect of inoculating cholam seeds on growth and yield. Work is in progress.

(iv) *Associated growth of cholam and pulse.*—Preliminary experiments on the field scale were started to study the effect of associated growth of cereals and pulses. It was seen that a cholam : pulse ratio of 3 :1 was most favourable from the point of view of both crops.

(v) *Legume nodule cultures.*—Cultures of nodule bacteria were prepared for soy bean and groundnut, and distributed for use in various agricultural stations.

11. *Sugarcane work*—(i) *Mineral composition of jaggeries.*—A detailed analysis was carried out of the mineral content of several jaggeries made from different varieties of cane and of different qualities. It was seen that no correlation existed between the ash content and quality of jaggery. It would, therefore, appear that the cause of poor quality in jaggery does not lie in its ash content as generally believed.

(ii) *Chemical composition of jaggeries.*—Studies in continuation of previous years' work on this subject showed that one of the causes for poor quality in jaggery was the presence of non-sugar organic matter, and that the fraction extractable by alcohol, was highest in jaggeries of poor quality. Work is in progress on the isolation and identification of the component substances of the alcohol extract.

(iii) *Effect of manuring on quality of cane juice.*—A study of field data has shown that the application of ammonium sulphate as a source of nitrogen is attended by the presence in the juice of that fraction called ' non-sugar organic matter ' which has been shown in paragraph above, to have an effect on the quality of jaggery. Castor cake produced the least quantity of this group of substances. It is a popular belief that castor-cake is a very suitable manure for sugarcane. These results seem to bear out the truth of that belief.

It is also known that ammonium sulphate though it may have a beneficial effect on the sugarcane crop, is not suitable for sugarcane meant for jaggery making, as it has an adverse effect on the quality of jaggery.

Further work is in progress in pot culture on the problem.

12. *Agricultural industries*—(i) *Activated carbon from paddy husk.*—Active carbon from paddy husk was prepared in bulk as in the previous year, but on a restricted scale for supply to the VIII Circle and to meet the needs of research done by the section. A total quantity of 1,500 lb. was prepared.

The process was modified slightly to effect savings in costs, without loss of efficiency in the final product. The modifications may be summarized as follows :—

(*a*) The quantity of caustic alkali required for activation, was reduced from 25 per cent to 15 per cent on weight of char. The treated char was subject to a strong heating in the tube of the furnace, and then washed thoroughly. The resulting product had a high efficiency.

(*b*) Washing of the treated char was done with cold water instead of hot water, without prejudice to the quantity of the final product.

(*c*) First carbonization of the paddy husk was carried out in open trays heated by the flue gases from the main furnace and thus giving more accommodation in

the main combustion chamber for the heating for the second time of the first char. This contributed to an increased output in the furnace.

(ii) *Activated carbon from other materials.*—Experiments were made in the preparation of active carbon with a variety of waste materials, i.e., groundnut husks, coffee husk, saw dust, cotton stalks, coconut husk, and spent avaram bark. The methods employed were based on the process for making carbon from paddy husk with modifications according to the material and a high grade active carbon was prepared. Large scale trials were made with groundnut husks, but were not quite successful and further work is in progress.

Trials with rice-mill char, when the material was a char produced by burning paddy husk in an ordinary furnace, were not successful, since the mill char contained a large quantity of ash. If, however, the char is collected after raking out the ash, it may be possible to produce a high grade carbon.

(iii) *Reactivation of spent carbon.*—It was found that if the active carbon had been used for the filtration of pure juices (cane juice) only once, it was possible to reactivate it by simple strong heating for two hours, when the carbon regained its original activity and capacity for decolourization. If, however, the juice filtered was of low purity, and the carbon was used more than once, its reactivation involved the alkali treatment following strong heating.

(iv) *Active carbon preparation by other departmental officers.*—Active carbon was being prepared at the Agricultural Research Station, Anakapalle and Palur for supply to the circles in those vicinities. Plans and details were supplied to these research stations for the erection of the furnace and preparation of the carbon, and samples of active carbon received from these stations were of good quality.

(v) *Active carbon-making by private parties.*—With the advice and help rendered by this section, two ryots in the Palladam taluk, with successful results, prepared active carbon for their use. M.R.Ry. Ramachandra Reddi Garu of Ambur also asked advice on active carbon-making and advice was rendered to him. He is now manufacturing carbon and on a large scale, for his own use.

(vi) *Enquiries from other Provinces and States.*—Enquiries were received from the Bombay Department and small quantities of carbon were supplied to officers of that department at Bulsar, Surat district, Belgaum, Padegaon, Poona and Pandharpur; in the Hyderabad State, M.R.Ry. Lakshmi Narayana Rao Garu was supplied with carbon at the instance of the Director of Agriculture, Madras. Another request from the Agricultural Chemist to His Exalted Highness the Nizam's Government at Himayat Sagar Farm will be met during the next year.

I had an opportunity of discussing the use of active carbon with the Agricultural Chemist, Poona, and the Deputy Director of Agriculture, Poona Circle, in the making of open pan sugar on

a large scale, while I was at Poona in March 1936, in connexion with work for the Bombay University, and with the Agricultural Chemist and Deputy Director of Agriculture, Hyderabad Circle, while on tour in the Hyderabad State in January 1936. Much interest was evinced by the officers of the Hyderabad State, where sugarcane growing is rapidly developing in the Nizamabad district under the Nizam Sagar Project.

(vii) *Fundamental research on active carbon.*—Preliminary studies were started on the factors that control activity of active carbon. Raw materials used and the respective carbons made therefrom were examined for their microstructure. The adoption of a special technique enabled microtome sections to be taken for photography under the microscope.

It was seen that the cellular structure of the raw material materially affected the quality of the final product and its activity and that the micro-structure were not altered by the product being activated by impregnation. Further work is in progress.

(viii) *Experiments on cream jaggery.*—Laboratory trials were made on the problem of reddening of some juices on boiling, though the filtrate came through water-clear. This effect causes the formation of colour in cream jaggery. It was found that by bubbling CO_2 through the boiling juice, this could be eliminated almost completely. Large scale trials are now being carried out. Another set of laboratory studies have indicated that with jaggery made from poor quality juices, if the charge is removed at 120° C, and then allowed to cool slowly by keeping it on a water bath, before putting into moulds, the crystallization is much more satisfactory and yields a fair quality of jaggery. The same juice, if treated in the ordinary way, yielded a soft low grade product.

(ix) *Coconut jaggery.*—Small scale experiments with coconut juices, clarified by active carbon yielded excellent jaggery, provided the lime was removed by phosphoric acid or super.

(x) *Clarification of edible oils.*—Paddy husk carbon was used for clarifying impure samples of coconut, castor, groundnut and gingelly oils with marked success. The process was one of simple filtration through a bed of active carbon. Coconut and groundnut oils filtered through almost water-clear, while gingelly and castor oils lost much of the usual unpleasant rancid odour bazaar samples possess. The commercial possibilities of such clarification by a simple process are very great.

13. *Malting of cholam.*—This work was started during the year, financed by a grant from the Imperial Council of Agricultural Research. Results are reported in a separate report to the Imperial Council of Agricultural Research.

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AGRICULTURAL RESEARCH INSTITUTE,
LAWLEY ROAD, P.O. COIMBATORE,
18*th May* 1936.

ADMINISTRATION REPORT OF THE GOVERNMENT ENTOMOLOGIST FOR THE YEAR 1935-36.

I beg to submit the following report on the activities of the Entomology section for the year ending 31st March 1936.

II.—Charge.

Rao Sahib Dr. T. V. Ramakrishna Ayyar was in charge of the section from 1st April 1935 to 7th June 1935 and from 8th July to 19th July 1935. I was in full additional charge of the section from 8th June to 7th July 1935, during his leave on average pay and took over charge of the post of Government Entomologist with effect from 20th July 1935, on which date Dr. Ramakrishna Ayyar retired from service. I continued to be in charge of the section for the rest of the year under report except for a short period of nine days from 3rd to 11th January 1936, when I was on leave on average pay.

III.—Enquiries and Noteworthy Pests of the Year.

There were altogether 320 reports from various parts of the Presidency. Most of these related to insect pests of crops and their control methods. There were also enquiries on apiculture and Eri silk-worm rearing and requests for identification of insects from different parties. Of the 320 enquiries received by me, 82 were attended to personally by members of the staff and in the other cases advice was given by correspondence. In addition to those received by the section, the Entomological Assistants posted to the different circles in the Presidency, also dealt with a number of enquiries a short report of which will be found in the section on ' Entomological work in the districts.'

The following are some of the more important pests which received attention during the year under report :—

(1) The paddy borer beetle (*Rhizopertha dominica*) from Kistna.
(2) The brinjal stem borer (*Euzophera perticella*) from Kadambattur.
(3) Tingids on jasmine from Coimbatore.
(4) Ants (*Dorylus sp.*) damaging roots of garden plants from Valparai.
(5) The red ant (*Oecophylla sp.*) on mango from Pudukota and on oranges and lime from Chidambaram.
(6) The rice Chrysomelid (*Leptispa pygmœa*, B.) from Pattambi.
(7) Mealy bugs on plantains from Maruteru and on sugarcane from Mayavaram.
(8) *Epilachna* on brinjals from parts of Coimbatore.

(9) The paddy mealy bug (*Ripersia oryzæ*, Gr.) from parts of Malabar.

(10) The coconut beetle (*Oryctes rhinoceros*, L.) from Coimbatore and Madras.

(11) The chillies thrips (*Scirtothrips dorsalis*, H.) from Erode and on Cambodia cotton from Bellary.

(12) The pomegranate butterfly (*Virachola isocrates*, F.) from Musiri and Amayanayakanur.

(13) The rice grasshopper (*Hieroglyphus banian*, F.) from Palghat.

(14) The cane mealy wings (*Aleurolobus barodensis*) from Mayavaram.

(15) The jasmine bug (*Antestia cruciata*, F.) from Tudiyalur.

(16) White ants in grass slips from Coimbatore, in buildings from East Godavari and in live red-gum plants from Kotagiri.

(17) The Lantana bug (*Orthezia insignis*, D.) from the Agri-Horticultural Society, Madras.

(18) Fruit sucking moths (*Ophideres* spp.) damage to oranges from Coimbatore and Nagercoil and to tomatoes from Tudiyalur.

(19) The rice weevil (*Calandra oryzæ*) on cholam from Tiruchengode.

(20) The coconut caterpillar (*Nephantis serinopa*, M.) from Kombay (Madura) and Lalgudi (Trichinopoly).

(21) The cane fly (*Pyrilla perpusilla*, W.) from Kuttalam (Tanjore).

(22) The castor slug (*Parasa lepida*, Cr.) on mango from Coimbatore.

(23) The paddy fulgorid (*Sogata pallescens*, *Dist*) on paddy from Ellore.

(24) The gram caterpillar (*Chloridea*) on cowpea from Hosur and on Bengal gram from Coimbatore.

(25) The mango leaf webber (*Orthaga exvinacea*, M.) from Palladam.

(26) The Agathi weevil (*Alcides bubo*, Fb.) damaging young agathi seedlings from Somanur.

(27) The paddy striped bug (*Tetroda histeroides*, F.) on paddy from Erode.

(28) The mango stem borer beetle (*Apate submedia*, *wlk.*, sp.) from Udamalpet.

(29) Semilooper caterpillars on agathi leaves from Singanallur.

(30) The rice caseworm (*Nymphula depunctalis*, G.) from Telungupalaiyam.

(31) Fruit flies (*Dacus* sp.) on guavas from Musiri.

(32) The cholam earhead bug (*Calocris*) from parts of Coimbatore.

(33) The paddy stem borer (*Schœnobius incertellus*, W.) from Tanjore area.

(34) The mealy bug (*Pulvinaria psidii*, M.) on chillies from Mettur (Salem).

(35) The beetle pest (*Alphitobius lævigatus*, *F.*) breeding in fish guano from Malabar.

(36) Fleas in buildings from Ootacamund.

(37) Cutworms (*Euxoa segetum*, S.) damaging lucerne from Ootacamund.

(38) The Pyralid (*Corcyra cephalonica*, *Stu.*) infesting preserved banana figs from Coimbatore.

(39) Stem boring longicorn grub from Fruit Research Station, Koduru.

(40) The zeuzerid stem boring caterpillar (*Zeuzera coffeæ*, N.) on pomegranate from Pattambi.

(41) The sugarcane top borer (*Scirpophaga*) from Patna.

(42) Wasps (*Palarus orientabs*, *kohl.*) attacking honey bees from Salem and Ponnani.

(43) Psyllids (*Diaphorina citri*, K.) on curry leaf (*Murrayia koenigi*) from Coimbatore.

(44) The 'Surul' puchi (*Stomopteryx nerteria*, M.) on groundnut from Coimbatore.

(45) The red hairy caterpillar (*Amsacta albistriga*, W.) on gingelly from Karur.

(46) The citrus leaf miner (*Phyllocnistis citrella*, S.) from Calicut.

(47) Caterpillars (*Dichocrocis punctiferalis*, G.) on cardamoms from Kollengode.

(48) Moringa leaf caterpillar (*Noorda*) from Coimbatore.

In addition to the above, several enquiries relating to non-insect pests such as rats, mites, etc., were received and attended to during the year under report.

IV.—Special Investigations During the Year.

Besides the attention paid to the various pest enquiries and reports received during the year from various parts of the Presidency, intensive studies were made of some of the major crop pests and considerable data gathered. Some of these have been continuations of the studies of the previous year. The more important of these items of research are the following :—

(1) *The paddy stem borer* (Schœnobius incertellus).—An intensive study of the pest under several aspects was

carried on at Coimbatore throughout the year in co-operation with the Paddy Specialist and the Central Farm authorities, paying special attention to (*a*) incidence—varietal and seasonal, (*b*) behaviour of the pest's life cycle in relation to the age and variety of the crop at different periods in the year, (*c*) the effect of a light trap on the degree of damage to the crop as well as its effective range, (*d*) the nature of the broods and their time of appearance in relation to the age of the crop, and (*e*) the effectiveness of the various means of control and the like. With the above point in view, counts of white ears were taken for several types and varieties, early and late in the season at the Central Farm, Paddy Breeding Station and in the adjoining villages round about Coimbatore. In this connexion, data were collected also from Palghat, Pattambi and the Tanjore delta as opportunities occurred. The late maturing as well as the second crop showed invariably a heavier percentage of attack and there was no variety completely resistent. The fortnightly planting at the paddy station indicated several interesting features with regard to incidence and damage, besides the behaviour of the pest studied under field conditions. The Central Farm light trap trials clearly showed a marked difference in the extent of damage between the experimental area and the average condition outside, besides revealing the fact that that the range of efficiency of a 200 candle power light is only a radius of about 350 yards as estimated by counts of ' white ears.'. It was found necessary to have continuous trapping for about 40 days only for two broods, under single crop conditions at the Central Farm. As estimated by the counts of dead hearts, tillers, eggmasses, moths, etc., in trial and control plots in ryot's field it was found that ' seedling selection ' at planting, was not by itself, a method of control to minimize injury to the crop, at a time of moth abundance. Apart from the above observations, efforts were made to study the life history of the insect at the Insectary in potted plants and in the field in field cages. Search was made for alternate food plants and stubbles were examined to follow the pest during off-season. Plenty of eggmasses from the field were also collected to study the parasites.

With regard to the bionomics of the insect, it appears that the insect's best season of activity is during periods of moist warm weather with plenty of standing water for the crop. Under such favourable circumstances the insect multiplies successfully, the larvæ are most active and the moths are of normal size and bright colour.

In the above work, the data collected at the Agricultural Research Stations, Pattambi and Maruteru, were examined for comparison.

(2) *The paddy army worm* (Spodoptera mauritia, B.).—The life history study of this insect was continued for six broods at the end of which the moths failed to lay eggs in March 1936, with the change in weather conditions. The structure of the pupæ, in the sexes, the habits in pupation, the duration of the life cycle in successive broods, were specifically noted. The behaviour of the insect under field conditions was noted in several places such as Coimbatore, Palghat, Pattambi and Mullasseri, at different parts of the year, all in young paddy, sown in puddle. The special study of the moths' activity and incidence, in the kole paddy, was continued and interesting notes made. Very important observations were added on the following points, mainly (*a*) the manner of actual egglaying at night in field and elsewhere, (*b*) the occurrence of two predatory beetles and a possible parasite which lays eggs in the eggs of the host, (*c*) the possibility of moths being induced to lay eggs on suitable host plants, for destruction of eggmasses in a collected form, and (*d*) the effectiveness of certain baits and light traps for destruction of moths and the like.

The year's observations are again suggestive of the strong and profound influence of the microclimatic conditions in attracting large influx of moth population in the area all on a sudden within 3–4 days of sowing and germination of the crop.

(3) *Pests of tomato.*—The pests of tomato studied during the year were *Laphygma*, *Chrotogonus*, *Prodenia* and *Ophideres* spp. Of these, *Laphygma* appeared in the nurseries and was kept in check by dusting calcium arsenate. The trouble from *Chrotogonus* which was a pest of fresh transplants was got over by planting more seedlings than the required number. *Prodenia* was only a leaf feeder in the beginning but later on attacked the fruits also by boring into them. This was checked by systematic handpicking of caterpillars. By far the most serious pest of tomato was the fruit sucking moth; it was, in fact, a menace to tomato cultivation both in the previous year and during the year under review. The moths were noted in very large numbers at night sucking the fruits as a result of which rotting set in and the fruits were found unfit for human consumption. As many as five moths were found on a single fruit on certain occasions. Both *Ophideres materna* and *O. fullonica* were noticed, the former predominating. Of all the control methods tried, the most effective was bringing suddenly a bright light near the moths at the time of feeding which stupified them. As the moths were then unable to fly they were handpicked easily and destroyed; thus hundreds of moths were exterminated.

(4) *Fruit flies.*—Trypetids or fruit flies are known to infest different kinds of fruits and as many as twenty species have been collected in South India. During the year, the life history and bionomics of the Coccinia fly—*Dacus brevistylus*—were studied in detail. Another fly—*Dacus ferrugineus incisus* noted breeding in mango, guava, tomato, orange, plum, etc., was found inside berries of one of the wild Solanums common in the Nilgiris—*Solanum verbascifolium.* To study the seasonal incidence of the flies, the Solanum berries are being collected every month for examination. Besides these studies, fly control methods, such as poison baits, were under trial. Parasites of the flies also received some attention.

(5) *Cotton bollworms* (*Platyedra and Earias*).—The relative percentage of infestation of the bollworms in Cambodia, Uppam and Karunganni was studied, week by week, in one of the fields in the Central Farm. Cambodia cotton at the foot of the Anamalais was also examined for the bollworms.

Experiments were devised to study the attraction, if any, of the pink bollworms (*Platyedra*) to certain chemical substances. Oils of geraniol, citronella, cinnamom, clove and amygdale; amyl acetate, oil of lemon grass, terpionol, eugenol and oil anisi were exposed in glass vials in cotton fields but none of these attracted any moths. Blue and green coloured lights also had no attraction for them. Attempts to rear *Microbracon lefroyi*—a parasite of the pink bollworm did not succeed though the larvæ were stung and paralysed. It is proposed to do breeding work using gelatine capsules as receptacles for the host caterpillars.

(6) *The cotton stem weevil* (*Pempheres affinis*).—Counts taken in January in one of the Central Farm fields showed that Cambodia, Uppam and Karunganni had 52·0 per cent, 9·8 per cent and 0·6 per cent of infestation, respectively.

As desired by the Director of Agriculture, Madras, different taluks in Salem and Madura districts from which petitions to exempt the area from the operations of the Pest Act, were inspected for noting the infestation due to the stem weevil and the bollworms. Some information has been obtained during the year regarding the distribution of Pempheres in India and also in foreign countries. In India, apart from the Madras Presidency, Bihar and Burma are the other places where the pest has been reported. In Bihar, according to the Imperial Entomologist, the weevil was found as early as 1905–06, damaging Caravonia, American and Deshi cottons. The pest has been found in *Cannabis sativa, Triumphetta neglectum* and *Hibiscus esculentus.* From Burma, the weevil has been reported for the first time during 1934–35, breeding

in the stem of a 'hybrid variety of cotton.' Of the foreign countries which had been addressed on the subject, viz., Cyprus, Egypt, Fiji, Kenya, Nigeria, Palestine, Pretoria, Philippines, Queensland, Sierra Leone, Straits Settlements and Federated Malay States, Tanganyika and United States of America, Philippine Islands is the only place where the weevil has been noticed and that on cotton. The information gained so far has been placed at the disposal of the Cotton Specialist for the use of the Parasitologist.

(7) *Moth borers of sugarcane.*—In South India, the most important pests of sugarcane are the moth borers and we have two species of *Diatraea* (D. *sticticraspis* and D. *venosata*) and two species of *Scirpophaga* (S. *monostigma* and S. *auriflua*) with us. The study of these borers was continued during the year. Information on the early symptoms of damage done by caterpillars is being gathered with a view to applying control methods in time. In the case of Scirpophaga, the moths found in the field are regularly collected for noting the proportion of the two species and the season for their emergence. Special attention is being devoted to the parasites of the different borers to see whether these could be reared in large numbers and liberated in affected fields. A canepest calendar for the Madras Presidency was prepared during the year.

As recommended by the Committee of Entomologists convened by the Imperial Council of Agricultural Research to discuss the scheme on sugarcane pests, the central scheme will come into operation shortly and detailed studies will have to be made in the Provinces and States for the next five years. The proceedings of the Committee will show that the work expected from the Provinces and States is very heavy indeed and unless more staff is forthcoming, it will not be possible to do justice to the subject.

(8) *The diamond back moth* (*Plutella maculipennis*).—Cabbages grown on the insectary field showed a severe infestation of the diamond back moth and hence a study of this pest was taken up. Of the control methods tried, Derris root powder was found very effective. During the course of the investigations, a fairly effective Chalcid parasite of the caterpillars was noticed and its habits were studied.

(9) *Pests of Moringa pterygosperma.*—A study was made of the caterpillars infesting the leaves and buds of this plant. Examination of the flower heads during different months showed that in certain months about 80 per cent of the buds were affected. The pests and the parasites were studied in detail. Trials of repellents such as crude oil emulsion, bordeaux mixture, sulphur, etc., are being made.

(10) *The Fluted scale* (*Icerya purchasi*).—The present position of the notorious fluted scale—*Icerya purchasi*—in the

Nilgiris against which the Entomological section has liberated its predator—*Vedalia cardinalis*—has been examined during the year. Slight infestation was noticed on wattles, rose, gorse and *Oxalis* sp., in a few places but wherever the scales were present the predators were also in evidence. For the first time Icerya was noticed on a few tea bushes in Kotagiri but prompt measures were taken to destroy them.

(11) *Mite pests of crops.*—Among non-insect pests, Mites (*Acarina*) are coming into prominence. During the year, reports of mite attack were received from Guntur, Penukonda, Tindivanam, Coonoor and Coimbatore on different crops such as cholam, castor, rose, fig, cotton and jasmine. Dusting with flowers of suphur has given satisfactory results. The results of the studies of mites have been written up and a paper on " The mite pests of crops in South India " was sent to the Indian Science Congress.

(12) *Natural enemies of crop pests.*—During the year, studies of the Hymenopterous and Tachinid parasites of different crop pests received some attention. Detailed notes were prepared of these insects for publication.

(13) *Trials of insecticides.*—Hillo, vermol, derris root, nicotino-sulphate, activated fish oil rosin soap and four different kinds of vegetable insecticidal soaps were under trial during the year. The trials will be repeated and reports sent to the various firms concerned in due course.

(14) *Pests of stored products.*—The relative incidence of the grain beetle—*Rhizopertha dominica*—on different varieties of paddy received from the Paddy Specialist was studied during the year. Similar experiments have been started with the weevil—*Calandra oryzæ*—on various varieties of cholam got from the Millets Specialist. Studies on the bionomics of the pulse bruchid—*Bruchus analis*—were made at the insectary.

(15) *House flies.*—Experiments in the control of flies by means of fly maggot traps were continued. Trials were made to see whether the addition of certain chemicals to the dung in the trap had any added attraction for flies to oviposit. Various substances such as citronella oil, amyl acetate, eucalyptus oil and amyl butyrate were sprayed on the dung at the rate of $\frac{1}{4}$ oz. in a gallon of water and of these, the citronella oil gave the best results as evidenced from the larger number of maggots caught in the trap.

(16) *The cholam leaf disease.*—Work on this was continued from October and carried on till the following January when the experimental plots were harvested. Counts of affected plants showed a total infestation of 12 per cent of which the " yellow " had 4·8 per cent and the " stripe " 7·2 per cent. The cholam shoot bug from affected plants

when transferred on to healthy seedlings raised under muslin topped chimneys were able to transmit the disease and the plants developed the characteristic symptoms within a week of transference. The plants inoculated by the pin prick and smearing methods did not take infection and remained healthy in either case.

Some of the grasses on the bunds such as *Brachiana ramosa*, B. *Ischæmum* and *Dichanthium annulatum* showed symptoms similar to those found on affected cholam plants. Since the intensity of the disease was more pronounced towards the bunds it is suspected that the grasses may be carriers of the disease. Experiments will be carried out to see whether the grasses have anything to do with the cholam disease. Colour plates and photographs of the affected cholam and grass plants were prepared.

V.—Life History Studies and Pest Control Work at Headquarters.

At the insectary which was in charge of Assistant Entomologist Mr. T. V. Subrahmanyam the usual breeding of insects collected locally and received from outside was carried on by all the members of the staff. The following were the more important insects that received attention :—

(1) The fluted scale (*Icerya*) and its predator (*Vedalia*).
(2) The wax moth (*Galleria mellonella*).
(3) Wasps (*Palarus orientalis*, *koh.*) attacking honey bees.
(4) The leaf caterpillar (*Noorda*) of Moringa pterygosperma and its parasites.
(5) Cutworms on lucerne.
(6) *Leptispa pygmœa* on paddy.
(7) The diamond back moth of Cruciferæ (*Plutella maculipennis*, C.) and its parasites.
(8) Fruit sucking moths (*Ophideres* spp.).
(9) The sugarcane top borer (*Scirpophaga*) and its parasites.
(10) A *Braconid* parasite on *Prodenia* caterpillars.
(11) *Oncocephala tuberculata* on *Ipomœa sepiaria*.
(12) The Lycaenid caterpillar (*Talicada nyseus*) on *Bryophyllum*.
(13) The Coccinia fruit fly (*Dacus bevistylus*, B.).
(14) The fig hairy caterpillar (*Perina nuda*, Fb.) and its parasites.
(15) A caterpillar pest of agathi.
(16) *Blastophaga* sp. in *Ficus glomerata* fruits.

The various members of the staff spent some time in attending to pest control work in the Central Farm and breeding stations. The important pests which were treated were capsid bugs on guavas; tingids on brinjal and jasmine; thrips on chillies; hairy caterpillars on sunnhemp; epilachna on brinjal; aphids on lab-lab, orange, cotton, melons, cabbage, etc.; castor slug on mango; mites on grapevine and castor; and caterpillar pests of different crops.

VI.—Plant Quarantine and Fumigation Work.

About 102 lots of various seeds received from officers of the department and private parties were examined for insect pests, fumigated when necessary and pest-free certificates issued. These included (1) seeds of paddy for despatch to Great Britain, Russia, Federated Malay States, Belgian Congo and Japan and those received here for trials from Russia, (2) samples of millets for despatch to Orange Free State, Trinidad, Queensland, Ceylon and Great Britain and those received for trials from China, Sudan, South Africa, Northern and Southern Rhodesia, Japan and United States of America, (3) oil seeds to Russia and Canton (China), (4) cotton seeds for despatch to Bengal, S. Bulgaria, Leningrad, Rangoon, China, French Somali Coast and Saigon, and those received for trials from West Indies and Uganda, (5) coffee seeds for despatch to Coorg, Tarikere and Kollengode, (6) potato tubers to Nanjanad Farm, and (7) Sudan grass to Ottawa, Canada.

At the request of the Millets Specialist, his field laboratory infested with store insects was fumigated with Calcium cyanide.

In addition to this, some appreciable time was devoted by the section in examining and passing seed canes for the Government Sugarcane Expert.

VII.—Beekeeping.

Numerous enquiries on beekeeping from different parts of India were received and attended to during the year under report. Our apiary was the centre of attraction to numerous visitors interested in this cottage industry. There was a great demand for bee colonies, hives, extractors, etc., which was met as far as possible. There is therefore every reason to believe that beekeeping as a cottage industry is gaining rapid popularity.

An average strength of about 40 bee colonies was maintained, throughout the year. The condition of the colonies was quite satisfactory during April and May but from June to September there was a decline in their strength owing to adverse weather and pasturage conditions. Consequently there was also trouble from the natural enemies such as the wax moth (*Galleria melonella*), the yellow banded wasp (*Vespa cincta*) and the Sphingid (*Acherontia styx*). There was, however, considerable improvement in the progress of the hives after the receipt of light showers in September and October. During the year, three out-apiaries were opened at different centres of the estate to solve the problem of finding adequate pasturage for bees and this had its desired effect.

Besides the routine maintenance of the hives, research work on various aspects of beekeeping was continued and considerable progress was made in the study of items such as bee pasturage, range of flight of workers, control of natural enemies such as the wax moth and the black-ant, swarm control, egg-laying capacity of the queen, effect of shifting bee colonies, etc.

A good deal of propaganda work was also done by the section. The short course on beekeeping which was instituted last year was conducted this year also in February. Twenty-five students from various parts of the Presidency joined the course. Apart from lectures, practical training was given in hiving wild colonies and swarms; extracting; ripening and storing honey; checking bee enemies such as the wax moth caterpillar, wasps, etc.; and in handling bees generally. The students were also taken on short excursions to see apiaries owned by private parties. Most of the students took a very keen interest in the subject and it is earnestly expected that they will begin beekeeping in their respective localities.

Demonstrations in handling and hiving of bee colonies were given at various centres such as Kumbakonam, Nidamangalam, Kotagiri, Salem, Ponnani and Palghat and these were well attended. As a result of our demonstrations a few private apiaries are now maintained in all these places.

Besides giving demonstrations, apicultural exhibits were sent to various exhibitions and practical suggestions given to those interested in the subject.

The bulletin on " Beekeeping " prepared by the Assistant in charge is in great demand everywhere and most of the copies have been sold out; and, as suggested by you, a revised second edition is being prepared.

During the year, the following apicultural requisites were distributed :—

Hives with bees 9; empty hives 51; bee colonies only 2; smokers 7; honey extractors 6; and queen excluder 1.

VIII.—Ericulture and Lac Culture.

Eight broods of eri worms were reared during the year mainly for the purpose of supplying eggs to rearers in different parts of the Presidency. A few mulberry silkworms were also reared for demonstration purposes.

Lac colonies liberated on different trees on the estate to see whether they would thrive under Coimbatore conditions were kept under observation. Their progress during the year was not quite satisfactory due mainly to the activities of the predator moth—*Eublemma*.

IX.—Entomological Work in the Districts.

The Entomological Assistants deputed to the different circles under circle officers had a very busy time attending to pest enquiries and collecting information on the various pests of crops in their respective localities. They organized campaigns, conducted demonstrations and took part in exhibitions.

The Entomological Assistant in the I Circle, besides doing propaganda work on beekeeping, conducted demonstrations for the control of the mango stem borer, *Laphygma* on ragi, chillies

thrips, Aphids on brinjals, Aleurodids on cane and organized campaigns for the Red hairy caterpillar of groundnut, Army worm of paddy and the paddy Fulgorid—*Sogata pallescens, Dis.*

In the II Circle, in addition to attending to reports, on *Spodoptera* and *Schœnobius* on paddy; leaf rollers and semiloopers on cotton; *Papilio* caterpillars on citrus; mites on cholam; and thrips on chillies, the Entomological Assistant devoted some time to the study of the cholam earhead bug—*Calocoris.*

The more important insects which received attention in the III Circle were fruit flies on Zyzyphus; *Prodenia* on Daincha; *Spodoptera* on paddy; semilooper on castor; mites on fig; citrus leaf caterpillar; mealy bugs on betelvine; and the chillies thrips. Demonstrations in beekeeping were also given as time permitted.

In the IV Circle, the more important pests tackled by the Sub-Assistant were the Red hairy caterpillar; lab-lab Aphis; Epilachna on brinjals; and *Antigastra* on gingelly.

The Entomological Assistant stationed at Aduturai in the V Circle was busy with the hairy caterpillar campaign for three months in the year. Besides studying the habits of the paddy mealy bug which is a serious pest in the circle, he attended to the other pests of paddy such as *Hispa, Pachydiplosis* and *Schœnobius* and pests of citrus, guava and chillies. He devoted some attention to popularize beekeeping.

In the VI Circle, the main work of the Assistant was in connexion with control methods for the chillies thrips and the pomegranate fruit borer. Some attention was also paid to grasshoppers on cereals, white ants on sugarcane, Aphids on lab-lab, Epilachna on brinjals, etc.

The Entomological Assistant in the VII Circle spent his time in demonstrating control methods for Rice hispa, Coconut caterpillar, Mango hopper and other pests. Some information was gathered on the pests of cashew and the insect fauna of grass lands. He devoted a good deal of his time in popularizing beekeeping.

The VIII Circle had the help of the Entomological Section at Coimbatore to attend to its needs. The more important of the enquiries received during the year are mentioned under " Enquiries and noteworthy pests of the year."

X.—Collections and Systematic Work.

Due to the retrenchment of the post of the Systematic Assistant Entomologist and the increase in items of economic work, it was not possible for the members of the section to do much in the way of systematic work. However, some work was done in Hymenopterous parasites, Trypetids, Aphids and Acarina.

Consignments of various insect orders were submitted to the Imperial Institute of Entomology, London, Bureau of Entomology, Washington, Professor Drake of Iowa, Dr. Takahashi of Japan, Mr. Bromley of Massachusetts and also to other specialists

for identification and our thanks are due to them for the help rendered in this connexion.

In addition to this, small lots of insects were identified by us for various parties, among which include—thrips on sugarcane for the Imperial Entomologist, Pusa, Aphids on sugarcane for the Government Sugarcane Expert, Coimbatore, Sandal insects for the Research Ranger, Denkanikota, Salem, and Michelia insects for the Forest Research Institute, Dehra Dun.

Specimens of insects were also sent on loan to various specialists for their study—Lac parasite (*Campyloneurus indicus*) to the Entomologist, Lac Research Institute, Ranchi, the Prickly-pear cochineal (*Dactylopius tomentosus*) and the Lantana bug (*Orthezia insignis*) to the Imperial Entomologist, Pusa, *Orseoliella apludæ* to Mr. M. S. Mani, Indian Museum, Calcutta, Ichneumonids to the Government Museum, Madras, and *Leptispa pygmæa* to Mr. S. Maulik, British Museum, London.

Our collections of insects are increasing every year and will have to be sorted out, classified and incorporated into the collections. For this as well as systematic studies on various economic groups there is urgent need for the revival of the post of the Systematic Assistant Entomologist.

XI.—Scientific Papers Prepared and Published.

The following papers were prepared during the year :—

(1) " The Soorai disease of paddy " by M. C. Cherian, P. N. Krishnaswami, S. Ramachandran and C. V. Sundaram—published in the " Madras Agricultural Journal."

(2) " A note on the Jassid pests of paddy " by M. C. Cherian—published in " Current Science."

(3) " Mite (Acarina) pests of crops in South India " by M. C. Cherian.

(4) " Bionomics of the swarming caterpillar of paddy in South India " by K. P. Anantanarayanan, and Dr. T. V. Ramakrishna Ayyar.

(5) " Some problems connected with the stem borer pest of rice in South India " by Dr. T. V. Ramakrishna Ayyar and K. P. Anantanarayanan.

(6) " Kole cultivation of rice in the Malabar Coast with special reference to insect pests " by Dr. T. V. Ramakrishna Ayyar and K. P. Anantanarayanan.

(7) " Some control experiments on the Deccan grasshopper " by M. S. Kylasam.

(8) " Agricultural Meteorology in its relation to insect pests " by Dr. T. V. Ramakrishna Ayyar and K. P. Anantanarayanan—published in the " Madras Agricultural Journal."

(9) " The leaf curl disease of chillies by thrips in Guntur and Madura " by Dr. T. V. Ramakrishna Ayyar, M. S. Subbayya, and P. S. Krishnamurti—published in the " Madras Agricultural Journal."

(10) " Some hints to amateur beekeepers in South India " —published in the " Villagers' Calendar, 1936."

Of these papers, (3) to (7) were presented at the Agricultural section of the Indian Science Congress held at Indore in January 1936.

A note on " An undescribed Tingitid from South India " prepared by Professor Drake of Iowa from material sent by us was sent for publication in the Proceedings of the Bombay Natural History Society.

In addition to these, various other items such as short notes on entomological subjects for publication in the newspapers, schemes on beekeeping and " agricultural meteorology in relation to insects " and popular account of the work of the Entomology section till 1934 for a revised edition of " The Popular account of the work of the Madras Agricultural Department " were prepared and submitted during the year.

XII.—Miscellaneous.

(1) *Artists' work.*—The following items of work were attended to in the Artists' section under my supervision :—

Pen and ink drawings 224; charts 213– sketches 48; photographs 710; prints 2,400; enlargements 266; lantern slides 658; and labels 1,347.

Though the main items of work were for the experts at the institute, every opportunity was taken to help the circle officers as far as possible. In a few cases other provinces and states were also helped.

In this connexion it has to be pointed out that for the more efficient supervision of the work of the artists it will be better if they are brought back to the institute.

(2) *Exhibitions and shows.*—Show-cases of insects and coloured plates, posters and bromide enlargements of various crop pests and beneficial and useful insects were sent to the following shows and exhibitions during the year :—

(i) All-India Swadeshi and Industrial Exhibition, Salem.
(ii) College Day and Conference Exhibition in the Freeman Building of the Research Institute.
(iii) Citrus Exhibition at the Fruit Research Station, Kodur.
(iv) Park Fair Exhibition, Madras.
(v) Agricultural and Industrial Exhibition at Srirangam during Vaikunta Ekadasi festival.
(vi) All-India Khadi Exhibition, Calicut.
(vii) Provincial Co-operative Conference Exhibition, Mercara.
(viii) District Co-operative Conference Exhibition, Palghat.
(ix) Agricultural and Industrial Exhibition, Mangalore.
(x) Health and Baby Week Exhibition, Coimbatore.
(xi) All-India Swadeshi Exhibition, Coimbatore.

The Insect Museum attached to the section continued to attract large numbers of visitors and served a useful purpose in educating the ryots in methods of pest control.

(3) *Research Council.*—I attended the half-yearly meetings of the Council in August 1935 and March 1936 when the half-yearly programmes of the section were discussed.

(4) *Special lecture.*—As desired by the Principal, I delivered a lantern lecture on " Acarina and their economic importance " to the students of the I and II year B.Sc.Ag. classes.

The students were also given demonstrations in beekeeping and in dusting and spraying appliances.

(5) *Sugarcane pests research.*—As kindly permitted by Government, I attended the meetings of the Committee of Entomologists convened by the Imperial Council of Agricultural Research at New Delhi, in February 1936 to discuss the sugarcane pests' scheme.

(6) *Supply of live parasites to foreign Entomologists.*—Mr. W. B. Gurney, Entomologist, New South Wales, visited Coimbatore, in connexion with the study of fruit fly parasites. As permitted by you, he was given every facility for working in the insectary and for collection of parasites in Coimbatore and the Nilgiris. He left for New South Wales at the end of December with a consignment of parasites bred at our insectary.

At the request of Doctor Hutson, Entomologist, Ceylon, live Eulophid parasites of the coconut caterpillar were sent for breeding and liberation in affected coconut topes.

M. C. CHERIAN,
Government Entomologist.

30*th April* 1936.

ADMINISTRATION REPORT OF THE GOVERNMENT MYCOLOGIST FOR THE YEAR 1935-36 (DETAILED REPORT).

The research items pursued during the year based on the three years' programme were as follows :—

Investigation of—

(1) The Foot-rot disease of paddy caused by the fungus *Fusarium moniliforme.*

(2) Mosaic disease of sugarcane.

(3) Black shank disease of tobacco caused by *Phytophthora parasitica.*

(4) *Piricularia* and *Helminthosporium* diseases of ragi.

(5) Wilt disease of crops caused by *Macrophomina phaseoli.*

(6) Yellowing disease of cholam.

(7) Panama disease of plantains caused by *Fusarium cubense var. inodoratum.*

(8) Areca palm—*Thielaviopsis.*

(9) Cereal rusts.

(10) Diseases of orchard and vegetable crops.

(11) Soil fungi.

1. *Paddy—Foot-rot—Seed treatment experiments.*—Previous experiments had shown that the disease could be effectively controlled by seed treatment with an efficient fungicide and "Ceresan," a proprietary preparation in the form of fine powder, gave the best results with regard to the control of the disease. Its highly poisonous nature, however, was a drawback and its use could be recommended only with great caution among the South Indian cultivators. It was thought desirable, therefore, to investigate if common fungicides like copper sulphate and bordeaux mixture could not be used instead and accordingly a field experiment was laid out in the Central Farm wet-lands at Coimbatore to see if these are effective in controlling the disease. Seed of a highly susceptible variety (*Arupathamkodai*) was first artificially infected with the spores of the fungus and then steeped for varying periods in solutions of (1) copper sulphate, (2) copper sulphate and then lime water and (3) bordeaux mixture of different strengths. One lot was treated with ceresan to serve as a basis of comparison and another lot without any treatment served as a control for all the series. In the second series, steeping in lime

water was intended to minimize the inhibitory effect of copper sulphate on the germination of the seed. Sowing was done on the 16th September 1935 and each series was repeated four times. The disease manifested itself in about ten days and periodical counts of the incidence of the disease were recorded till harvest time (Table I).

The results of the experiment show—

(1) that treatment with bordeaux mixture is not very effective,

(2) that copper sulphate is more effective than bordeaux mixture, and

(3) that treatment with copper sulphate (followed by lime water) is not of any appreciable advantage.

2. *Sugarcane—Mosaic—Varietal resistance trials.*—The field experiment started in the year 1926 to assess the relative resistance of sugarcane varieties to mosaic was continued and 28 varieties were included in the trial during the year under report (Table II).

The varieties Co. 354, Co. 515, Co. 426, Co. 417, Co. 419, Co. 313, Co. 360, Co. 429, Co. 361 and Co. 331 showed infection ranging from 40 to 60 per cent.

Co. 326, Co. 229, Co. 335, Co. 355, Co. 356, Co. 508, Co. 413 and P.O.J. 2878 remained uninfected during the year.

Co. 411, Co. 412 and Co. 353 showed a high degree of resistance.

Varietal resistance trials—Inoculation.—Of the varieties which proved resistant in the field, a few were again subjected to artificial infection by the pin-prick method in order to test if the freedom from disease noted in the variety was due to its inherent resistance or to an accidental escape, either owing to the inability of the vector to penetrate the tissues or to any other cause. Co. 205 took infection and symptoms of mosaic developed in 14 days. This variety has been reported to be susceptible to mosaic in Pusa, but has so far been found to be free in the experimental plots in Coimbatore. The result of the inoculation experiment is therefore interesting inasmuch as this variety which remains unaffected in the field in spite of very favourable conditions for mosaic infection takes infection when the virus is introduced artificially. It would therefore appear that the variety Co. 205 is not immune to mosaic; but that the conditions of spread of the disease in Coimbatore are not favourable for its taking infection. Further experiments are in progress to see if this is due to the inability of " vector " to transmit the disease to Co. 205 canes in Coimbatore.

Histological studies.—To find out if there is any change in the structure of the tissues of the leaf of the cane consequent on mosaic affection, microtome sections of the leaves of two varieties of canes affected with mosaic were taken and compared with

the structure of the leaves of the healthy plants of the same variety. No essential difference could be noticed between the healthy and the diseased except in the reduction of size of cells and in the fewer number of chloroplasts.

Seed transmission.—The experiment started last year to test if the " virus " is transmitted through true seed was repeated this year. Seed from mosaic affected Co. 213 plants from the mosaic experimental plots was collected and sown in pots and care was taken to see that there were no chances of external infection. The plants were examined periodically and no mosaic was discernible in the plants even two months after planting. The results obtained are in conformity with that obtained last year, viz., that the virus does not pass through true seed to the next generation.

Masking.—It was noticed (in 1934) that in two varieties Co. 360 and Co. 361, the mottling symptoms disappeared in the infected canes after some time (30–70 days) and the infected canes to all appearance were perfectly normal and healthy. In order to see if the disappearance of the symptoms was the result of the attenuation of the virus attended with the recovery of the plants from the disease or only cases of masking of symptoms, setts from the plants were planted and it was observed that the plants raised from them did not show symptoms of the disease. A series of inoculation trials were made in this connexion.

Masked Co. 361 to healthy Co. 361.
,, to healthy Co. 213.

No infection occurred. The possibility of the canes recovering from the disease is suggested, but pending further investigation no definite statements can be made. The plants raised from setts from the masked plants were inoculated by the pin-prick method with mosaic virus from diseased Co. 213 plants. No infection occurred in the inoculated plants and the result suggests the possibility of the plants having acquired immunity on account of previous infection.

3. *Tobacco—Black shank caused by Phytophthora parasitica var, nicotianæ—Field experiments.*—An experiment was laid out in Attur (Salem district) to find out suitable control measures against this disease. The treatments consisted of (1) sterilization of seed-bed, (2) disinfection of seed and (3) protection of plant in the nursery and in the transplanted field with a fungicide. The results are appended (Table III A and B). For sterilization of seed bed, burning trash on the surface was found to be the cheapest and most effective. For disinfection of seed, silver nitrate 1 in 1,000 solution was found to be the most effective. Though this stuff is costly, its use need not be ruled out in the case of tobacco diseases, since only a very small quantity of the chemical need be used for seed treatment. For the protection of seedlings and transplants, spraying with 1 per cent Bordeaux mixture (about three times) was found effective. Though the treatments have to be extended from the seed to the transplanted crop, they are quite simple

in themselves and can be easily adopted by the ryots for a valuable money crop like tobacco. The damage caused by the disease is great and adoption of remedial measures is worthwhile.

In the Central Farm, the above experiment was duplicated and the results tally with those obtained at Attur and the treatments were found equally effective against " Damping off."

Varietal resistance.—A large number of tobacco varieties were grown in pots and their reaction towards " black shank " fungus was tested by inoculation trials. Fourteen varieties were included in the trial, out of which four did not take infection.

(1) Adcock, (2) Pusa type, (3) Cash and (4) Shade. These appear to be resistant and seeds from these varieties have been preserved for further trials.

Laboratory studies.—Detailed studies of the fungus were made in the laboratory and experiments were carried out in the pot culture house to obtain knowledge on the mode of infection.

4. *Ragi—Helminthosporium.*—A Helminthosporium was isolated from specimens of *ragi* plants received from Bellary. The fungus was grown in cultures and inoculation trials were made. The fungus proved virulently parasitic on ragi especially in the seedling stage. The fungus causes foot-rot, leaf-spot and ear-head blight of ragi and attempts are being made to find out suitable control measures. Seed treatment is indicated, but the substitution of resistant varieties in badly infected area would appear to be a more effective measure and it is proposed therefore to direct attention towards varietal resistance trials.

Ragi—Piricularia.—A strain of Piricularia was isolated from diseased ragi plants got from the Nilgiri hills and brought into pure culture.

5. *Wilts—Studies in Macrophomina phaseoli—Horsegram wilt.*—The fungus " Macrophomina phaseoli " was isolated from wilted horsegram plants grown for green manure in the Millet Breeding Station, Coimbatore, and brought into pure culture and a series of inoculation experiments was carried out with a view to elucidate the following :—

(1) To test its pathogenecity on different hosts.
(2) To find out the stage at which the horsegram plants are most susceptible.
(3) To see if the disease is seed borne.
(4) To study the mode of infection.

(1) *Pathogenicity.*—Pure cultures of the fungus were mixed with sterilized soil in which horsegram plants were raised from disinfected seeds. The seedlings took infection from the very beginning in the course of the first three weeks and a large percentage of the plants took infection and succumbed. The plants which escaped infection during this period remained free throughout. The experiments proved that the fungus was a virulent parasite on horsegram in the seedling stage.

Cross inoculation experiments—Horsegram strain of Macrophomina phaseoli on other hosts.—The above experiment was repeated with the following host plants :—

(1) Blackgram,
(2) French bean,
(3) Cow pea,
(4) Gingelly, and
(5) Karunganni cotton.

	Number of plants under observation.	Number of plants that took infection.
1 Horsegram strain on blackgram	36	3
2 Horsegram strain on French bean	18	7
3 Horsegram strain on cow pea	16	Nil.
4 Horsegram strain on gingelly	24	Nil.
5 Horsegram strain on Karunganni cotton ..	16	Nil.

It would be seen that the strain was able to infect French bean and blackgram, but not cow pea, gingelly and Karunganni cotton.

The strains isolated from these different plants were on the other hand found to be parasitic to a varying degree on horsegram plants as is shown below :—

Strain used.	Number of plants under observation.	Number of plants that took infection.
French bean	10	3
Cow pea	10	3
Gingelly	10	9
Karunganni cotton ..	10	1

Stage at which the plants are susceptible to infection.—Inoculations were made on one week, two weeks and a month old plants with pure cultures of the fungus and it was seen that all the plants in the one-week old series took infection readily and succumbed, while only about 50 per cent of the plants in the other two series took infection.

Vulnerable part of the plants.—The inoculum was placed in different parts of the plant; on roots, collar, cotyledonary node, shoots and leaflets and the progress of infection noted. This experiment was also repeated in the laboratory on seedlings raised inside sterilized glass tubes. It was found that all parts alike were equally susceptible to infection, though in the last experiment the leaves appeared to be more susceptible than other parts.

Seed infection experiments.—Seed collected from diseased plants in the field when sown gave rise to perfectly healthy plants and likewise seed artificially infected with cultures of the fungus, when sown in sterilized soil, gave rise to healthy plants only. It would appear therefore that the disease is not seed borne.

Temperature studies.—An attempt was made to study the temperature relationship of the parasitism of the fungus in the course of the inoculation experiments and it was found that the optimum temperature of infectivity is about 28°C.

Biological antagonism.—Associated with the fungus, the following organisms were found in the soil :—

Fusarium, Aspergillus and Rhizopus.

In order to see if these organisms exert any inhibitory influence on the growth of " Macrophomina phaseoli," pure cultures of the different organisms were isolated and inoculated on plates along with *Macrophomina phaseoli*. These fungi do not appear to exert any influence on the growth of *Macrophomina phaseoli*, at least so far as could be judged by a study of the plate cultures in the laboratory. This observation, therefore, does not bear out the experience recorded elsewhere of a biological antagonism existing between the parasitic and non-parasitic fungi found in close association with each other in the soil.

Comparison of the strains of the fungus isolated from different host plants.—Strains of the fungus isolated from horsegram and French bean plants were grown in cultures of various media and compared. It was found that the horsegram strain isolated was more vigorous and profuse in growth than the other.

Pycnidial formation.—A large number of pycnidia was noticed on the stems of the host plant, but attempts made to induce pycnidial formation in cultures were not successful though a few abortive pycnidia were found occasionally.

Gingelly—Wilt.—The disease manifested itself in gingelly plants grown in infected soil during the hot weather, but failed to make its appearance in the cold season crop raised in the same soil, the experiment showing the great influence of the seasonal factor in the incidence of plant diseases.

Cotton—Wilt—Longevity experiments.—Cotton plants raised in soil infected with the fungus twelve months previously failed to take infection showing thereby that the fungus does not remain viable for so long a period.

A Macrophomina has been isolated from *Cuminum cyminum* received from Bellary.

Wheat—Foot-rot.—Two species of the fungus Helminthosporium were isolated from diseased wheat plants received from Kugalur near Gobichettipalaiyam. The fungi were brought into pure culture for further study.

6. *Cholam—Yellowing.*—The investigation of the disease was done in collaboration with the Government Entomologist. Infection and inoculation trials carried out prove that the disease is definitely of a virus origin and is transmitted by an insect vector "*Pundalaya simplicia,*" but not transmitted by the pin-prick method of virus transmission. The virus would appear to be of a kind which is easily destroyed by exposure and hence the failure of the pin-prick method.

Histological studies.—Microtome sections of diseased and healthy leaves were taken and studied after staining with Haidenhan's Iron-alum Hæmotoxylin solution.

7. *Plantain—Panama disease.*—The investigation of this disease was continued on the lines indicated in previous reports. The disease was noticed in a severe form at Valliyur (Nanguneri taluk in Tinnevelly district) in the variety *Chinna mondan.*

Seven varieties of plantain were planted in an infected field in Trichinopoly district to test their relative resistance. None of the varieties have so far taken infection and no definite results were obtained.

Treatment with Malariol.—Further trials with this oil were made and it was found that the oil was effective in killing the diseased plant and rendering it innocuous by preventing the fungus inside the rhizome develop spores which will spread infection to other plants.

8. *Areca palm—Bud-rot (Thielaviopsis?).*—A disease of areca palm hitherto unrecorded in South India has been noticed at Murkanad (Malabar district). The symptoms of the disease are : the leaves break at the joint with the leaf-sheath or a little higher, the leaflets turning yellow and drying up, the cabbage becomes thinner and thinner and the yield is considerably reduced. A large number of leaves are involved and in course of time the infection spreads to the central bud which is ultimately killed. The disease spreads rapidly in the rainy season and was noticed on an epidemic scale during the last season. The fungus Thielaviopsis was found closely associated with the diseased palms. The investigation of the disease has been taken on hand and the fungus has been brought into pure culture for further study.

9. *Cereal rusts.*—Uredo and teleuto spores of black, brown and yellow rusts of wheat were collected from Ootacamund and attempts were made to germinate them in the laboratory at various temperatures 3°C. to 30°C. The spores failed to germinate but spores of brown rust collected from Coimbatore germinated at laboratory temperature obtaining at the time.

Direct inoculation with uredo and teleuto spores of brown and black rust on 40 days old wheat plants did not cause infection.

The investigation of this problem has been transferred to the Research Assistant appointed recently for Rust Research under the Imperial Council of Agricultural Research.

10. *Diseases of orchard and vegetable crops—Citrus—Foliocellosis.*—The disease was noticed at Tiruttani in a severe form and an attempt was made to control the disease by spraying the plots with a solution of zinc sulphate and hydrated lime (10 lb. of zinc sulphate, 5 lb. of hydrated lime and 100 gallons of water). The experiment gave encouraging results and the trees showed signs of improvement.

Fig—Rust (Uredo Fici)—Control of the disease by dusting with sulphur.—Satisfactory results were obtained in the control of this disease with a new brand of 300 mesh sulphur put in the market by a Bombay firm. The sulphur on account of its extreme fineness adhered to the surface of the leaves better than the coarser brands that have been hitherto used.

Mildew on rose.—Dusting with sulphur gave good results against this disease also.

11. *Soil fungi.*—The investigation of the biology of soil fungi was continued on the same lines as indicated in last year's report. Estimation of fungal population in different kinds of soil was made. The population was estimated month by month. It was found that there was considerable reduction of the fungal flora during the month of June owing to dry weather. The black cotton soil (after fallow) showed greater number of fungi than red loam soil. It was also noticed that there were more fungi in a soil with a crop on than in a soil which was fallow. Fungal population was estimated at different depths of black soil.

Pathogenic fungi in soils and their relationship to non-pathogenic fungi.—An attempt was made to study the inter-relationship of non-pathogenic and pathogenic fungi in soils and experiments were carried out by isolating them and incubating on sterilized and partially sterilized soils. The work is in progress.

Miscellaneous.

(1) *Oils as spreaders.*—A series of spraying experiments were carried out at Michaelpatti, Madura district, to test the efficacy of indigenous oils as spreaders and adhesives to Bordeaux mixture. Three oils were included for the trial. (1) Neem, (2) Coconut and (3) groundnut. The oil was added to the copper sulphate solution prior to its being mixed with lime water in the preparation of Bordeaux mixture. The oil emulsified and the resultant mixture had good adhesive and spreading qualities. Spraying trials were carried out with these oil Bordeaux mixtures in comparison with resin-Bordeaux against grapevine mildew

in selected gardens at Michaelpatti and the results of the experiments are as follows :—

Garden.	Spray material.	Percentage of mildew attacked bunches to total.
I	Bordeaux mixture and groundnut oil	5·5
II	Bordeaux mixture and coconut oil	6·5
III	Bordeaux mixture and neem oil	8·0
IV	Bordeaux mixture and resin and soda	31·0

Cost of treatment per acre—for four sprayings.	RS.
Bordeaux mixture and resin and soda	84
Bordeaux mixture and groundnut oil	82
Bordeaux mixture and coconut oil	82
Bordeaux mixture and neem oil	78

The oils are found to be cheaper and more effective than resin-soda. At Michaelpatti neem oil is available locally in sufficient quantities, but in other places groundnut oil would appear to be more easily procurable. The results of the experiment are in conformity with the experience at Mysore.

(2) *Palmyra—Bud-rot.*—The Pest Act in respect of palmyra bud-rot was in force throughout the year in the Palghat, Ponnani and Walluvanad taluks in Malabar. A sub-assistant was stationed at Elapulle in connexion with this work and considerable progress was made in the cutting of diseased trees in the affected area.

The disease broke out in a mild form in the Tenali taluk, Guntur district, but steps were promptly taken to have the disease eradicated.

(3) *Paddy—Piricularia—Tanjore district.*—On a representation made by the Mirasdars' Association that the paddy crop was badly affected with this disease this year, a survey was made in the affected area and it was found that the disease had caused considerable amount of damage to the crop due to adverse weather conditions. The variety ' Korangu samba ' suffered most.

(4) *Microtome sub-section.*—The section continued to be in my charge during the year and 605 sections of material were cut and slides prepared.

(5) *Routine.*—Seventy-two specimens of diseased plants were received from different parts of the Presidency for examination and advice.

Twelve consignments of seed intended for despatch overseas were fumigated.

(6) *Special lectures.*—As desired by the Principal of the College I delivered two special lectures to the students of the B.Sc. class.

(7) *Publications.*—Two papers were submitted to the symposium on disease resistance held at Coimbatore in October 1935 under the joint auspices of the Association of Economic Biologists and Indian Science Academy :—

(i) " Estimation of disease resistance in paddy blast and foot-rot " by Mr. K. M. Thomas.

(ii) " Estimation of disease resistance in sugarcane mosaic " by Mr. C. S. Krishnaswami.

(8) *Study leave.*—It is gratifying to report that Assistant Mr. K. M. Thomas was awarded the degree of M.Sc. of the Madras University for his thesis on " Foot-rot of paddy." He was granted study leave to enable him to prosecute his studies in England for a period of one year.

S. SUNDARARAMAN,
Government Mycologist.

30*th April* 1936.

Table I.

Paddy Foot-rot—Seed treatment experiments—1935–36.

Number.	Treatment.	Percentage of disease.
1-a	Copper sulphate 1 per cent for 15 minutes	2·31
b	Do.	5·24
c	Do.	5·45
d	Do.	4·38
	Mean ..	4·35
2-a	Copper sulphate 1 per cent for 15 minutes followed by addition of lime water for another 15 minutes.	6·07
b	Do. do.	4·22
c	Do. do.	5·32
d	Do. do.	7·01
	Mean ..	5·66
3-a	Copper sulphate 2 per cent for 15 minutes	2·12
b	Do.	3·28
c	Do.	5·04
d	Do.	4·85
	Mean ..	3·82
4-a	Copper sulphate 2 per cent for 15 minutes followed by addition of lime water for another 15 minutes.	3·41
b	Do. do.	4·75
c	Do. do.	6·56
d	Do. do.	5·94
	Mean ..	4·92
5-a	Bordeaux mixture 1 per cent far 15 minutes	10·39
b	Do.	12·25
c	Do.	9·88
d	Do.	12·08
	Mean ..	11·15
6-a	Bordeaux mixture 2 per cent for 15 minutes	13·22
b	Do.	13·18
c	Do.	9·40
d	Do.	15·36
	Mean ..	12·79
7-a	Bordeaux mixture 1 per cent for 30 minutes	10·73
b	Do.	13·82
c	Do.	14·29
d	Do.	12·76
	Mean ..	12·90
8-a	Bordeaux mixture 2 per cent for 30 minutes	12·36
b	Do.	8·33
c	Do.	12·56
d	Do.	12·78
	Mean ..	11·51
9-a	Ceresan 1 grm. per lb. of seed	1·10
b	Do.	1·77
c	Do.	0·98
d	Do.	1·22
	Mean ..	1·27
10-a	Control	28·45
b	Do.	30·58
c	Do.	27·96
d	Do.	31·67
	Mean ..	29·67

Table II.

Statement showing the incidence of disease (mosaic) in the different varieties tried for varietal resistance in Field No. 59-C during the year 1935-36.

Serial number.	Name of varieties.	Percentage of infection.	Serial number.	Name of varieties.	Percentage of infection.
1	Co. 205 Pusa ..	Nil.	15	Co. 402	13·4
2	Co. 213	63·5	16	Co. 408	37·5
3	Co. 229	Nil.	17	Co. 411	1·9
4	Co. 313	63·4	18	Co. 412	7·2
5	Co. 326	Nil.	19	Co, 413	Nil.
6	Co. 331	38·0	20	Co. 417	43·5
7	Co. 335	Nil.	21	Co. 419	43·6 *
8	Co. 353	5·4	22	Co. 421	24·3 *
9	Co. 354	55·2	23	Co. 426	43·1
10	Co. 355	Nil.	24	Co. 429	39·9
11	Co. 356	Nil.	25	Co. 508	Nil.
12	Co. 360	55·4	26	P.O.J. 2878 ..	Nil.
13	Co. 361	53·4	27	Pundia	25·6
14	Co. 363	11·4	28	Co. 515	54·2

* Repeated thrice.

Table III-A.

Statement showing the incidence of disease in the experimental plots A at Ulipuram during the year 1935.

Serial number and treatment.	Total number of plants at the beginning.	Dates of observation. 12th March 1935. Number of deaths due to wilt.	12th March 1935. Percentage.	26th March 1935. Number of deaths due to wilt.	26th March 1935. Percentage.	3rd May 1935. Number of deaths due to wilt.	3rd May 1935. Percentage.	10th May 1935. Number of deaths due to wilt.	10th May 1935. Percentage.	Total number of deaths.	Percentage of attack.
1 Nursery treatment.	246	..	..	10	4·1	32	13·6	19	9·4	61	24·8
2 Nursery treatment and periodical spraying.	254	1	0·4	9	3·6	14	5·8	15	6·6	39	15·4
3 Nursery treatment.	377	4	1·1	20	5·4	52	14·8	45	15·0	121	32·1
4 Nursery treatment and periodical spraying.	340	2	0·6	10	3·0	12	3·7	14	4·4	38	11·2
5 Nursery treatment.	325	..	..	8	2·5	86	27·2	41	17·8	135	41·5
6 Control	409	2	0·5	9	2·2	122	30·7	52	18·9	185	45·2

Table III-B.

Statement showing the incidence of disease in the experimental plots B at Ulipuram during the year 1935.

1 Nursery treatment.	385	3	0·8	2	0·5	18	4·7	15	4·2	38	9·9
2 Nursery treatment and periodical spraying.	1,107	5	0·5	24	2·2	15	1·4	16	1·5	60	5·4
3 Spraying alone without nursery treatment.	120	5	4·2	..	..	..	..	..	..	5	4·2
4 Control	129	7	5·4	3	2·5	5	4·4	4	3·5	19	14·7